SE 611 : Software Metrics

GQM

Goal-Question-Metrics

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CHAPTER 1

Introduction

GQM, the initialism for "goal, question, metric", is an established goal-oriented approach to software metrics to improve and measure software quality.

GQM defines a measurement on three dimensions. They are-

Conceptual Level (Goal)

A goal is defined for an object, for a variety of reasons, with respect to various models of quality, from various points of view and relative to a particular environment.

Operational level (Question)

A set of questions is used to define models of the object of study and then focuses on that object to characterize the assessment or achievement of a specific goal.

Quantitative level (Metric)

A set of metrics, based on the models, is associated with every question in order to answer it in a measurable way.

We'll have to first fixate our goal, then develop a question set to collect data from related people or stakeholders. The questions must have appropriate metrics to measure the result later. We have to create a questionnaire to collect data from people defined in the scope. The last part will include metrics analysis with result derivation to finally reach an outcome.

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CHAPTER 2

Project Specification

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2.1 Project Overview

Our objective is to know if doing the Web technology course before our SPL-2 project would benefit the students to acquire a better outcome since having prior knowledge on web technology can be very useful for the project types given in our SPL-2. Current and former students of IIT may be able to help us with their experience during 5th semester to reach a conclusion on this matter.

2.2 Motivation

Web technologies are a fundamental part of software engineering and development. With that in view, we've to develop a project which is mostly a web application in SPL-2 in 5th semester. However, the Web Technology course is also taken during that semester. As a result, students may have to learn and develop parallely during that period. We could be benefited if we had prior knowledge in web technologies before that semester, so that we could grow and become more efficient to finally provide a better project outcome in SPL-2.

2.3 Scope

We have reached out to the current and former students of Software Engineering, some alumni who are now currently working in industries or institutions both in home and abroad to learn their experience throughout this learning curve.

CHAPTER 3

GQM Dimensions

"Evaluate the Effectiveness of Software Project Lab-2 (Web Project) & Web Technology Course Sequence to Improve Student's Web Development Skills."

This project aims to tackle the following issues:

- Understand the current development process

- Implement the user requirements properly

- Improve efficiency in development

- Acquire better learning curve

3.1 Sub-goals, Question & Metrics

Our goal has 4 main sub-goals:

A. Maximize student development skill

B. Minimize development effort

C. Maximize learning tools & effective tool selection

D. Building knowledge on architectural models and meeting user goals/satisfaction

3.1.1 GA. Maximize Student Development Skill

1. What development skills are needed to be learned?
   - Front end skill
   - Backend skill
   - Database skill
   - API usage skill

2. How to measure development skills?
   - Project size
   - LOC(Lines of Code)
   - Quality Code per unit time
   - Code Smell

3. What are the effective criteria to judge individual skill?
   - Quality Function Deployment
   - Number of Defects/ KLOC

4. How long does it take to solve a problem?
   - Developer-hour

3.1.2 GB. Minimize development effort

5. How to calculate effort?

    - Development Time

    - LOC

    - Number of developer

6. What development methods affect maintenance costs?

    - Pre-release records of methods and post-release costs

7. How maintainable is the product as changes occur?

    - Incoming problem rate

    - Detect Density

    - Code Stability

    - Complexity

    - Number of modules changed to fix one defect

8. What will maintenance requirements be?

    - Code Stability

    - Complexity

    - Size

    - Pre- release defect density

3.1.3 GC. Maximize Learning Tools & Effective Tool Selection

9. How to measure effective tools?

    - Gather others' feedbacks

    - Good Documentation

    - Enough internet resources

    - No. of global projects

    - Market demand

10. How can we judge if the student learns effectively?

    - Development skill

    - Number of defects/KLOC

3.1.4 GD. Maximize Architectural Models Learning & Fulfilling QFD

11. How to evaluate user satisfaction?

    - Survey

    - QFD

12. What are the suitable characteristics of an architectural model?

    - Application of well established architectural models for specified software solution domain

13. How to determine if users are happy with the UI?

    - Surveys

14. How to divide the system into appropriate modules?

- Conventional models of generic component design, previous experience

15. What is the appropriate strategy for distributing time in each module?

- Evaluating module size
- Module significance
- Functional priority

16. What is the basic knowledge for deploying a system?

- Knowledge of tools and techniques

CHAPTER 4

Questionnaire Preparation & Data Collection

After defining the Goal, Questions and Metrics, we prepared a survey questionnaire to collect data from the undergrad students who're currently studying doing bachelors in Software Engineering from IIT, all graduates and alumni from different industries and institutions who had their degree from Institute of Institute & Technology, University of Dhaka.

To analyze *"Evaluate the effectiveness of completing the SPL2 course before the Web Technology course in order to improve student development skills.",* we collected data about their experience on their SPL-2 project and Web Technology course to acquire a better understanding of how they accomplished their project. We also surveyed the technical sides of their project to get a good grasp of how they fared with all the web technologies they had to use. We also collected data about some specific fields like SRS or front-end development to measure their easiness with these tasks.

We'll ask about their grade on respective courses to compare the outcome and it'll have some statements with Likert scale questions to survey their opinion on this matter perfectly. Some questions are related to the challenges they've faced during their project development and what would've paved the way for better results.

A sample question is given below-

Q. "I would've performed better in SPL-2 project, if I had taken the Web Technology course earlier" - Do you agree?

1. Strongly Agree

2. Agree

3. Neutral

4. Disagree

5. Strongly Disagree

Full questionnaire can be found here- https://forms.gle/wnu9bcU5x9BuLg3k7

CHAPTER 5

Data Visualization

In this section, we'll see the summary of collected data, presented as charts like pie charts, bar charts etc.

Q1.

What was your grade in the Web Technology course?
30 responses
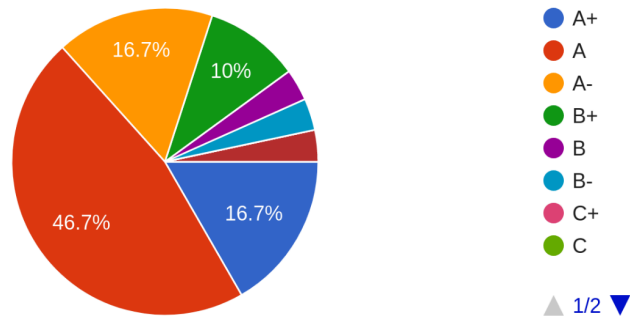
FIGURE-1 : Pie Chart for Grades

Q2.

What was your grade in the SPL-2 course?
30 responses
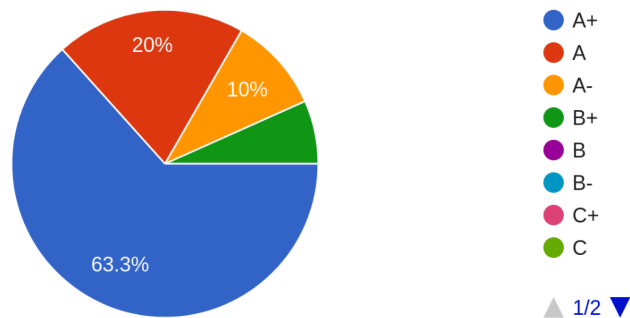
FIGURE-2 : Pie Chart for Grades

Q3.

What's your BSSE batch?

30 responses
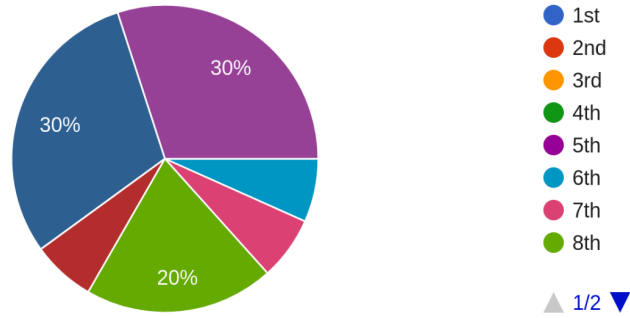
FIGURE-3 : Pie Chart for Batches

Q4.

On a scale of 1-5, how satisfied are you about your SPL-2 project?
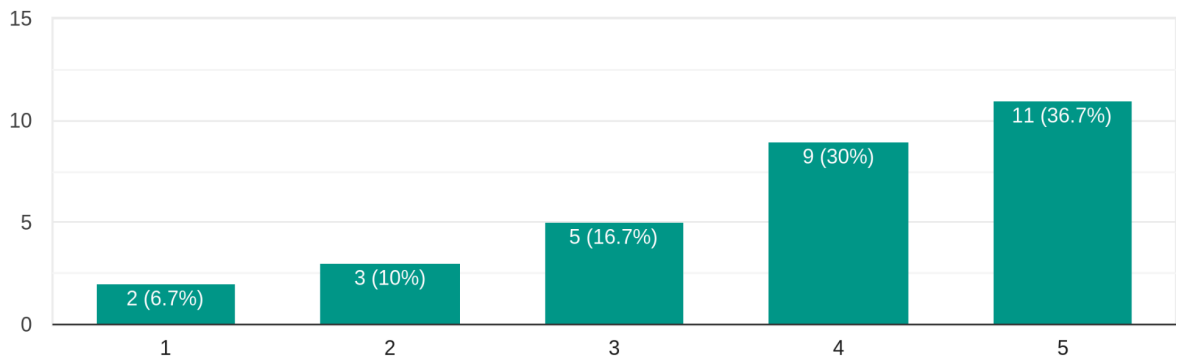
30 responses

FIGURE-4 : Bar Chart for Satisfaction Results

Q5.

On a scale of 1-5, how relatable was the Web Technology course with your SPL-2 project?
30 responses
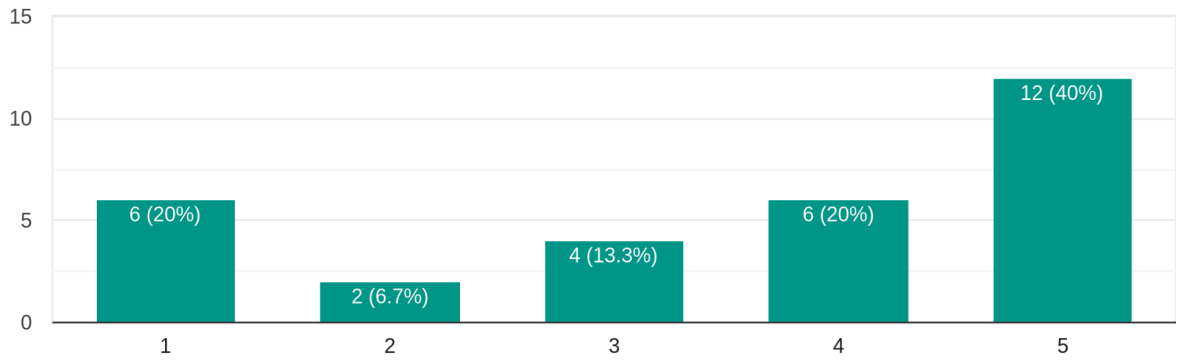
FIGURE-5 :   Bar Chart for Relevancy Levels

Q6.

How many days have you spent learning HTML, CSS & JavaScript?
30 responses
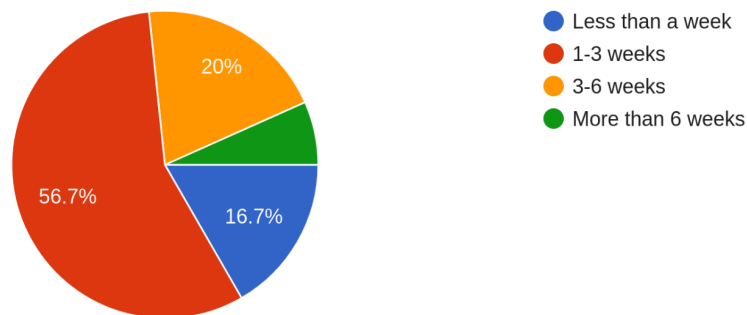
FIGURE-6 :   Pie Chart for Learning Duration

Q7.

Did you have any prior knowledge on the tools you've used to develop your SPL-2 project?
30 responses

● Little to None
● Moderate
● Complete

36.7%

63.3%
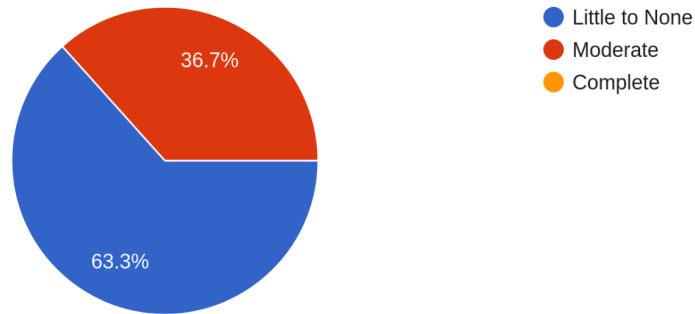
FIGURE-7 :   Pie Chart about if they'd any Prior Knowledge

Q8.

How easy have you found to design the SRS (Software Requirement Specification) document of your project?
30 responses

● Very Easy
● Easy
● Moderate
● Difficult
● Very Difficult

20%

56.7%

10%

13.3%
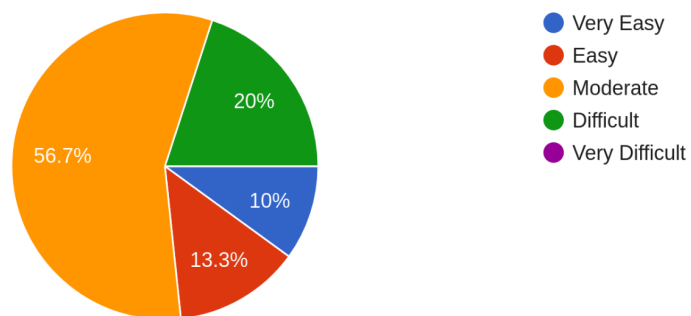
FIGURE-8 :   Pie Chart on SRS Difficulty

Q9.

How difficult have you found to develop the front-end of your project?
30 responses
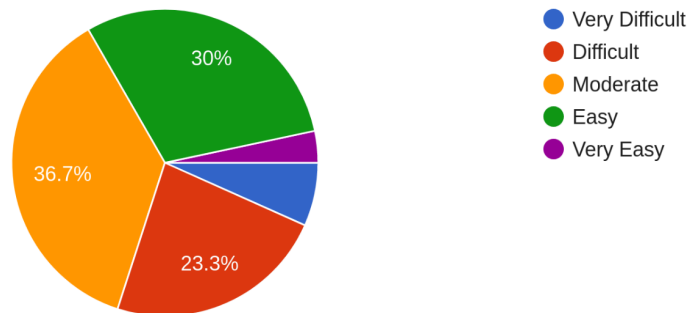
FIGURE-9 :   Pie Chart on Front-end Difficulty

Q10.

How long was the development phase of your project?
30 responses
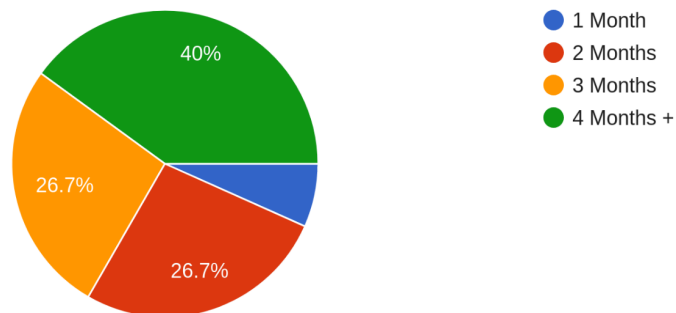
FIGURE-10 :   Pie Chart on Development Phase

Q11.

According to you, what was the level of user satisfaction from all the users' viewpoint?
30 responses

Legend:
- Very Satisfied
- Satisfied
- Neutral
- Frustrated
- Very Frustrated

23.3%
63.3%
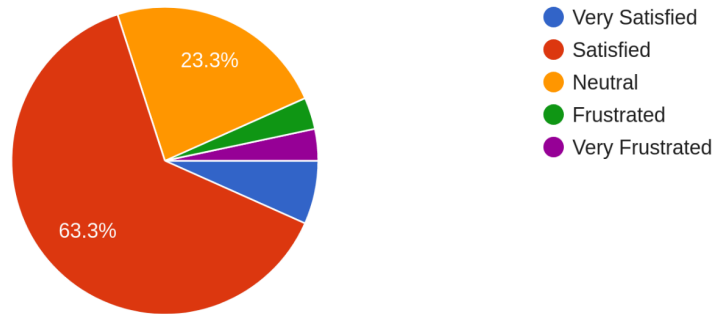
FIGURE-11 :   Pie Chart for User Satisfaction

Q12.

What was the biggest challenge in completing your SPL-2 project?
30 responses

Challenge	Value
Lack of technical knowledge	17 (56.7%)
Team coordination	7 (23.3%)
Time management	13 (43.3%)
Unlikeable project	6 (20%)
I strived for PERFECT, professi…	1 (3.3%)
Selection of project. Selection…	1 (3.3%)
Learning and implementing at t…	1 (3.3%)
evaluation strategy undertaken…	1 (3.3%)
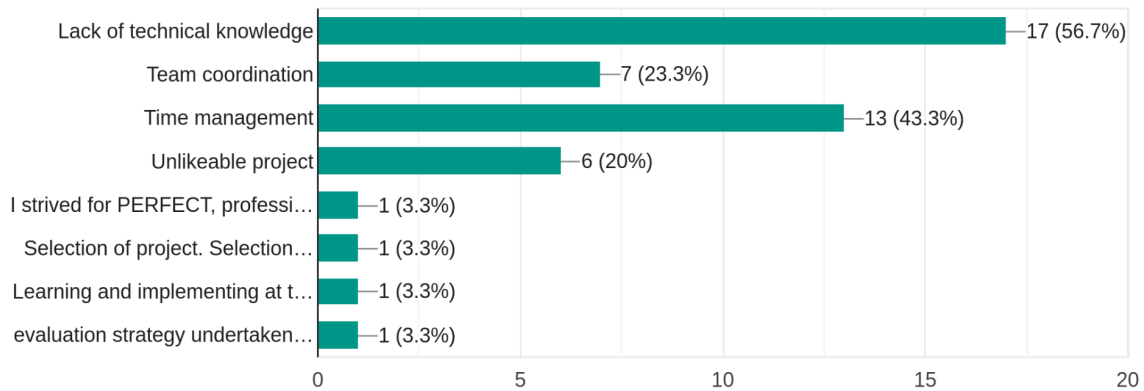
FIGURE-12 :   Chart for Biggest Challenges

Q13.

"I would've performed better in SPL-2 project, if I had taken the Web Technology course earlier" - Do you agree?

30 responses

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
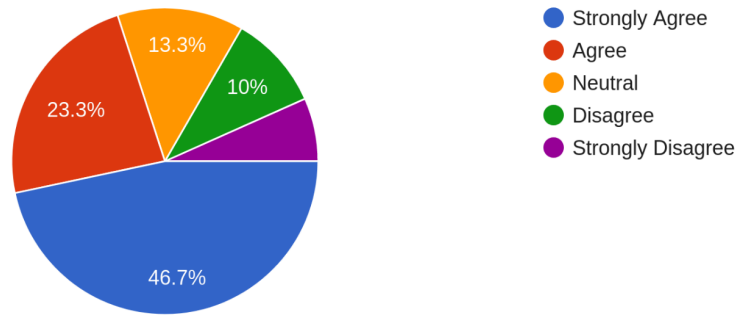
FIGURE-13 :   Pie Chart

Metrics Analysis

Q4. On a scale of 1-5, how satisfied are you about your spl-2 project?

On a scale of 1-5, how satisfied are you about your SPL-2 project?				Observed	Expected
1	2				
2	3			Observed	Expected
3	5		More than 3 ~ satisfied	25	15
4	9		Less than 3 ~ unsatisfied	5	15
5	11		p value	0.0002607296329	

FIGURE-14 : Chi-Square Test on Q4

No. of people who are satisfied	:	9 + 11 + 5	= 25
No. of people who are unsatisfied	:	2 + 3	= 5
Obtained p-value	:	0.00026 (approx)	

H_a : *There is an unequal number of respondents in satisfied and unsatisfied categories.*
H_0 : *There is an equal number of respondents in satisfied and unsatisfied categories.*

So for both categories our expected value is $\frac{30}{2} = 15$. **Chi square test** was done on the date. The p-value is calculated using the CHITEST function. The significance level is considered to be 0.05.

$$P - value = 0.00026 < 0.05$$

So the observed distribution is not the same as expected distribution. Therefore, We can conclude that most of the people are satisfied with their spl-2 project.

Q5. On a scale of 1-5, how relatable was the web technology course with your spl-2 project?

FIGURE-15 :   Chi-Square Test on Q5

No. of people who are find Web Tech unrelatable   :   6 + 2   =   8

No. of people who are find Web Tech unrelatable   :   6 + 12 + 4   =   22

Obtained p-value   :   0.01058 (approx)

H_a : *Web Technology was not relatable to equal no. of respondents..*

H_0 : *Web Technology was relatable to equal no. of respondents..*

So for both categories our expected value is $\frac{30}{2} = 15$. **Chi square test** was done on the date. The p-value is calculated using the CHITEST function. The significance level is considered to be 0.05.

$$P - value = 0.01058 < 0.05.$$

So the observed distribution is not the same as expected distribution. Therefore, We can conclude that most of the people find it relatable with their spl-2 project.

Q6. How many days have you spent learning HTML, CSS & JavaScript?

E19		fx	? =CHITEST(E17:E18,F17:F18)			
	A	B	C	D	E	F	G

14						
15	How many days have you spent learning HTML, CSS & JavaScript?					
16	Less than a week	5			Observed	Expected
17	1-3	17		Less than 3 weeks	22	15
18	3-6	6		More than 3 weeks	8	15
19	More than 6	2		p value	E19 .01058713733	CHI TEST
20					=CHITEST(E17:E18,F17:F18)	
21						

FIGURE-16 : Chi-Square Test on Q6

People who learnt Web Tech Basics in less than three weeks :   5 + 17   = 22

People who learn Web Tech Basics in more than three weeks :   6 + 2   = 8

Obtained p-value   :   0.01058 (approx)

H_a : *Unequal no. of respondents finished Web Tech Basics in less than 3 weeks.*

H_0 : *Equal no. of respondents finished Web Tech Basics in less than 3 weeks.*

So for both categories our expected value is 30/2=15. We have done our **Chi square test** in excel spreadsheet. The p-value has been calculated using the CHITEST function.

$$P - value = 0.01058 < 0.05$$

So the observed distribution is not the same as expected distribution. Therefore, We can conclude that most of the people learned HTML, CSS & JavaScript in less than three weeks.

Q7. Did you have any prior knowledge on the tools you've used to develop your SPL-2 project?

FIGURE-17 : Chi-Square Test on Q7

People who had 'below average' knowledge	:	19	=	19
People who had 'above average' knowledge	:	11 + 0	=	11
Obtained p-value	:	0.01441 (approx)		

H_a : Unequal no. of respondents had below average knowledge.

H_0 : Equal no. of respondents had below average knowledge.

So for both categories our expected value is 30/2=15. We have done our **Chi square test** in excel spreadsheet. The p-value has been calculated using the CHITEST function.

 So the observed distribution is not the same as expected distribution.

$$P - value = 0.1441 > 0.05$$

So the observed distribution is the same as expected distribution. Therefore, We can conclude that most of the people had below average knowledge prior to the SPL-2 project.

Q8. How easy have you found to design the SRS (Software Requirement Specification) document of your project?

FIGURE-18 : Chi-Square Test on Q8

People who found it easy to design SRS   : $3 + 4$ =   7
People who didn't find it easy to design SRS   : $17 + 6 + 0$ =   23
Obtained p-value   :   0.01058 (approx)

H_a : Unequal no. of respondents found SRS to be easy.
H_0 : Equal no. of respondents found SRS to be easy

So for both categories our expected value is $\frac{30}{2} = 15$. **Chi square test** was done on the date. The p-value is calculated using the CHITEST function. The significance level is considered to be 0.05.

$$P - value = 0.00348 < 0.05$$

So the observed distribution is not the same as expected distribution. Therefore, We can conclude that most of the people find it difficult to design their SRS document.

Q9. How difficult have you found to develop the front-end of your project?

E6	▼	fx	=CHITEST(E4:E5,F4:F5)			
	A	B	C	D	E	F	G

	A	B	C	D	E	F	G
39							
40	How difficult have you found to develop the front-end of your project?						
41	Very Difficult	2					
42	Difficult	7			Observed	Expected	
43	Moderate	11		Difficult	9	15	
44	Easy	9		Not difficult	21	15	
45	Very Easy	1		p value	0.02845973692	CHI TEST	
46							

FIGURE-19 : Chi-Square Test on Q9

People who found it difficult to develop front-end	:	2 + 7	= 9
People who found it easy to moderate to develop front-end	:	11 + 9 + 1	= 21
Obtained p-value	:	0.02845 (approx)	

H_a : Unequal no. of respondents found frontend development to be difficult.

H_0 : Equal no. of respondents found frontend development to be difficult

So for both categories our expected value is $\frac{30}{2} = 15$. **Chi square test** was done on the date. The p-value is calculated using the CHITEST function. The significance level is considered to be 0.05.

$$P - value = 0.02845 < 0.05$$

So the observed distribution is not the same as expected distribution. Therefore, We can conclude that most of the people find it not difficult to develop the front-end of their SPL-2 project.

Q10. How long was the development phase of your project?

	A	B	C	D	E	F	G
	E6		*fx*	=CHITEST(E4:E5,F4:F5)			
47							
48							
49	How long was the development phase of your project?						
50	1 month	2			Observed	Expected	
51	2 months	8		Less than 2 months	10	15	
52	3 months	8		More than 2 months	20	15	
53	4 months+	12		p value	0.06788915486	CHI TEST	
54							

FIGURE-20 : Chi-Square Test on Q10

People whose development phase was less than 2 months   : 2 + 8   = 10
People whose development phase was more than 2 months : 8 + 12   = 20
Obtained p-value   : 0.067889 (approx)

H_a : Unequal no. of respondents' development time was more than 2 months.
H_0 : Equal no. of respondents' development time was more than 2 months

So for both categories our expected value is $\frac{30}{2} = 15$. **Chi square test** was done on the date. The p-value is calculated using the CHITEST function. The significance level is considered to be 0.05.

$$P - value = 0.067889 > 0.05$$

So the observed distribution is the same as expected distribution. Therefore, We can conclude that most of the people find it not relatable with their spl-2 project.

Q11. According to you, what was the level of user satisfaction from all the users' viewpoints?

56						
57	According to you, what was the level of user satisfaction from all the users' viewpoint?					
58	Very satisfied	2				
59	Satisfied	19		Observed	Expected	
60	Neutral	7	Satisfied	21	15	
61	Frustrated	1	Not satisfied	9	15	
62	Very frustrated	1	p value	0.02845973692	CHI TEST	
63						

FIGURE-21 :   Chi-Square Test on Q11

People who were satisfied   :   2 + 19   =   21
People who were not satisfied   :   7 + 1 + 1   =   9
Obtained p-value   :   0.02845 (approx)

So for both categories our expected value is $\frac{30}{2} = 15$. **Chi square test** was done on the date. The p-value is calculated using the CHITEST function. The significance level is considered to be 0.05.

$$P - value = 0.02845 < 0.05$$

So the observed distribution is not the same as expected distribution. Therefore,We can conclude that most of the people find it that the users were satisfied with their spl-2 project.

Q12. What was the biggest challenge in completing your SPL-2 project?

| B74 | ▼ | fx | =CHITEST(B69:B73,C69:C73) |

	A	B	C	D
65				
66	What was the biggest challenge in completing your SPL-2 project?			
67				
68		Observed	Expected	
69	lack of technical knowledge	17	15	
70	Team coordination	7	15	
71	Time management	13	15	
72	Unlikeable project	6	15	
73	Other	4	15	
74	p value	0.001094450341	CHI TEST	
75				

FIGURE-22 : Chi-Square Test on Q12

Here, we considered that an average number of people should face difficulties in the mentioned sections - 'lack of technical knowledge', 'team coordination', 'time management', 'unlikeable project' & 'other' reasons.

Obtained p-value   :   0.00109 (approx)

H_a : *Average no. of respondents didn't face the mentioned challenges..*

H_0 : *Average no. of respondents faced the mentioned challenges.*

For the categories our expected value i.e., average is $\frac{30}{2} = 15$ for each challenge. **Chi square test** was done on the date. The p-value is calculated using the CHITEST function. The significance level is considered to be 0.05.

$$P - value = 0.00109 < 0.05$$

So the observed distribution is not the same as expected distribution. Therefore,We can conclude that most of the people find it relatable with their spl-2 project.

Q13. "I would've performed better in SPL-2 project, if I had taken the web technology course earlier." - Do you agree?

E6	▾	fx	=CHITEST(E4:E5,F4:F5)				
	A	B	C	D	E	F	G
76							
77	I would've performed better in SPL-2 project, if I had taken the Web Technology course earlier" - Do you agree?						
78	Strongly Agree	14					
79	Agree	7			Observed	Expected	
80	Neutral	4		Disagree	9	15	
81	Disagree	3		Agree	21	15	
82	Strongly Disagree	2		p value	0.02845973692		
83							

FIGURE-23 : Chi-Square Test on Q13

People who agree with the opinion   :   14 + 7   =   21
People who disagree with the opinion   :   4 + 3 + 2   =   9
Obtained p-value   :   0.028459 (approx)

H_a : Unequal no. of respondent agree with the statement.
H_0 : Equal no. of respondents who agree with the statement.

For the categories our expected value i.e., average is $\frac{30}{2} = 15$. **Chi square test** was done on the date. The p-value is calculated using the CHITEST function. The significance level is considered to be 0.05.

$$P - value = 0.028459 < 0.05$$

So the observed distribution is not the same as expected distribution.Therefore,We can conclude that most of the people agree that they could have performed better in SPL-2 project, if they had taken the web technology course earlier in their course timeline.

CHAPTER 7

Result of Analysis

We have 4 sub-goals with 10 questions and 10 hypotheses. Among them, we rejected 8 null hypotheses and could not reject 2 null hypotheses.

SI No.	Question	Hypothesis	Result
4.	How satisfied are you about your spl-2 project?	H0 : There is an equal number of respondents in satisfied and unsatisfied categories.	Most people had below average knowledge prior to the SPL-2 project.
5.	How relatable was the web technology course with your spl-2 project?	H0 : Web Technology was relatable to equal no. of respondents.	Most people find it difficult to design their SRS document.
6.	How many days have you spent learning HTML, CSS & JavaScript?	H0 : Equal no. of respondents finished Web Tech Basics in less than 3 weeks.	Most people find it not difficult to develop the front-end of their SPL-2 project.
7.	Did you have any prior knowledge on the tools you've used to develop your SPL-2 project?	H0 : Equal no. of respondents had below average knowledge.	Most people find it not relatable with their spl-2 project.
8.	How easy have you found to design the SRS (Software Requirement Specification) document of your	H0 : Equal no. of respondents found SRS to be easy	Most people find it that the users were satisfied with their spl-2 project.

SI No.	Question	Hypothesis	Result
	project?		
9.	How difficult have you found to develop the front-end of your project?	H0 : Equal no. of respondents found frontend development to be difficult	Most people find it relatable with their spl-2 project.
10.	How long was the development phase of your project?	H0 : Equal no. of respondents' development time was more than 2 months	Most people agree that they could have performed better in SPL-2 project, if they had taken the web technology course earlier in their course timeline.
11.	According to you, what was the level of user satisfaction from all the users' viewpoints?	H0: Equal no of respondents were satisfied with their spl-2 project	Most people find it that the users were satisfied with their spl-2 project.
12.	What was the biggest challenge in completing your SPL-2 project?	H0 : Average no. of respondents faced the mentioned challenges.	Most people find it relatable with their SPL-2 project.
13.	"I would've performed better in SPL-2 project, if I had taken the web technology course earlier." - Do you agree?	H0 : Equal no. of respondents who agree with the statement.	Most people agree that they could have performed better in SPL-2 project, if they had taken the web

SI No.	Question	Hypothesis	Result
			technology course earlier in their course timeline.

We tried to figure out if Web Technology should be taken before SPL II. We found that most (80%) of the responses indicate students face difficulties in Software Project Lab 2 as Web Technology is not taught before SPL2. And most of the students agree that Web Technology should be taught before SPL2.

CHAPTER 8

Conclusion

In our survey, we tried to find if taking the Web Technology course before our SPL-2 project would be beneficial or not. We created a questionnaire by having the psychology of the students in mind and collected their experience during their 5th semester at IIT.

In our questionnaire, we collected data about their experience on their SPL-2 project and Web Technology course to acquire a better understanding of how they accomplished their project. We also surveyed the technical sides of their project to get a good grasp of how they fared with all the web technologies they had to use. We also collected data about some specific fields like SRS or front-end development to measure their easiness with these tasks.

Then we analyzed the responses by using Chi-square test. From the results we can conclude that taking the Web Technology course before the semester in which we've our SPL-2 project would have been better for our learning curve and overall development. It would've given us time to grow with these technologies and our project later would be more handful with more skillful development with time.

Resources

Full questionnaire can be found here-

https://forms.gle/wnu9bcU5x9BuLg3k7

Excel sheet of the responses found after the survey-

 Will it be more effective to take Web Technology course before SPL-2? (Responses)

Excel sheet for metrics analysis-

GQM count - Google Sheets